# REFRACTORY CONCRETE


# LUMNITE

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# LUMNITE FOR REFRACTORY CONCRETE

## Index





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# The Atlas LUMNITE Cement Co.

United States Steel USS Corporation Subsidiary

Chrysler Building, New York • 208 South La Salle Street, Chicago

# REFRACTORY CONCRETE

## WHAT is Refractory Concrete?

Refractory Concrete is a concrete having refractory properties and suitable for service at high temperatures in furnaces and other industrial heating units. Refractory Concrete has cold strength, as placed, similar to that of ordinary structural concrete. After exposure to service temperatures a fired strength or "ceramic bond" is built up by the vitrification of the constituent materials.

## HOW is Refractory Concrete made?

Made with LUMNITE, refractory aggregates and water, Refractory Concrete is mixed and placed by methods similar to those employed for structural concrete. Furnace walls or other sections may be cast in place using forms of wood or steel. Precast units may be made and put in service as required without pre-firing. See Pages 6 to 13.

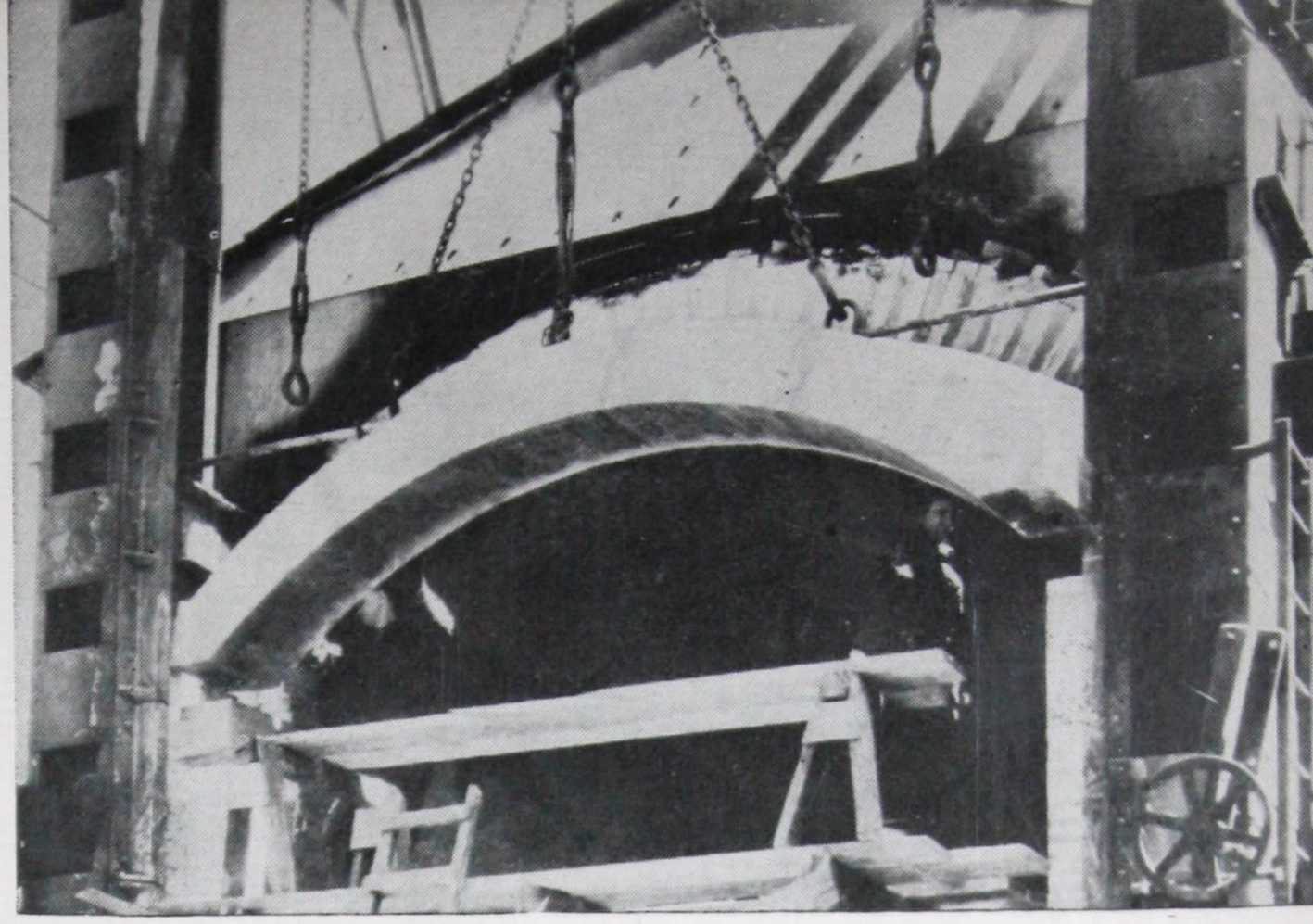
## WHY is Refractory Concrete used?

Economy of installation, maintenance and operation is the primary reason for the rapid extension of the use of Refractory Concrete. Materials are readily available. LUMNITE is sold by building supply dealers throughout the United States and Canada. Reserve stocks are maintained by the Atlas Lumnite Cement Company at twelve points in the United States. Aggregate, such as fire brick grog, can be prepared from salvaged refractories or may be purchased from manufacturers of refractories. Stocks of LUMNITE and aggregates in the plant represent but a small inventory item.

The adaptability of Refractory Concrete makes possible the ready placing of monolithic walls, linings and arches in locations which

Refractory Concrete Arch in Annealing Furnace.

This pre-cast arch, 15 feet 8 inches overall length, was hoisted into place 24 hours after casting.



would otherwise require the use of special shapes and entail high erection costs. Maintenance is facilitated by a cast-in-place refractory or by unfired precast units made to fit the job. The high 24-hour strength of LUMNITE concrete makes possible the application of the full working load within a day of placing. For the same reason precast units may be handled and installed within 24 hours. Operating economy results from the installation of monolithic Refractory Concrete walls—walls without joints. Combinations of refractory and insulating sections can be worked out with regard only to the desired thermal effects. The designer is not restricted by standard sizes of units and conventional wall thicknesses.

REFRACTORY CONCRETE
Doors for Core and Mold Drying Ovens in a Steel Foundry.

Refractory Concrete Roof Slab for Pit Annealing Furnace.
This roof slab had been in service about two years when the picture was taken.

## Heat Resistant Concrete

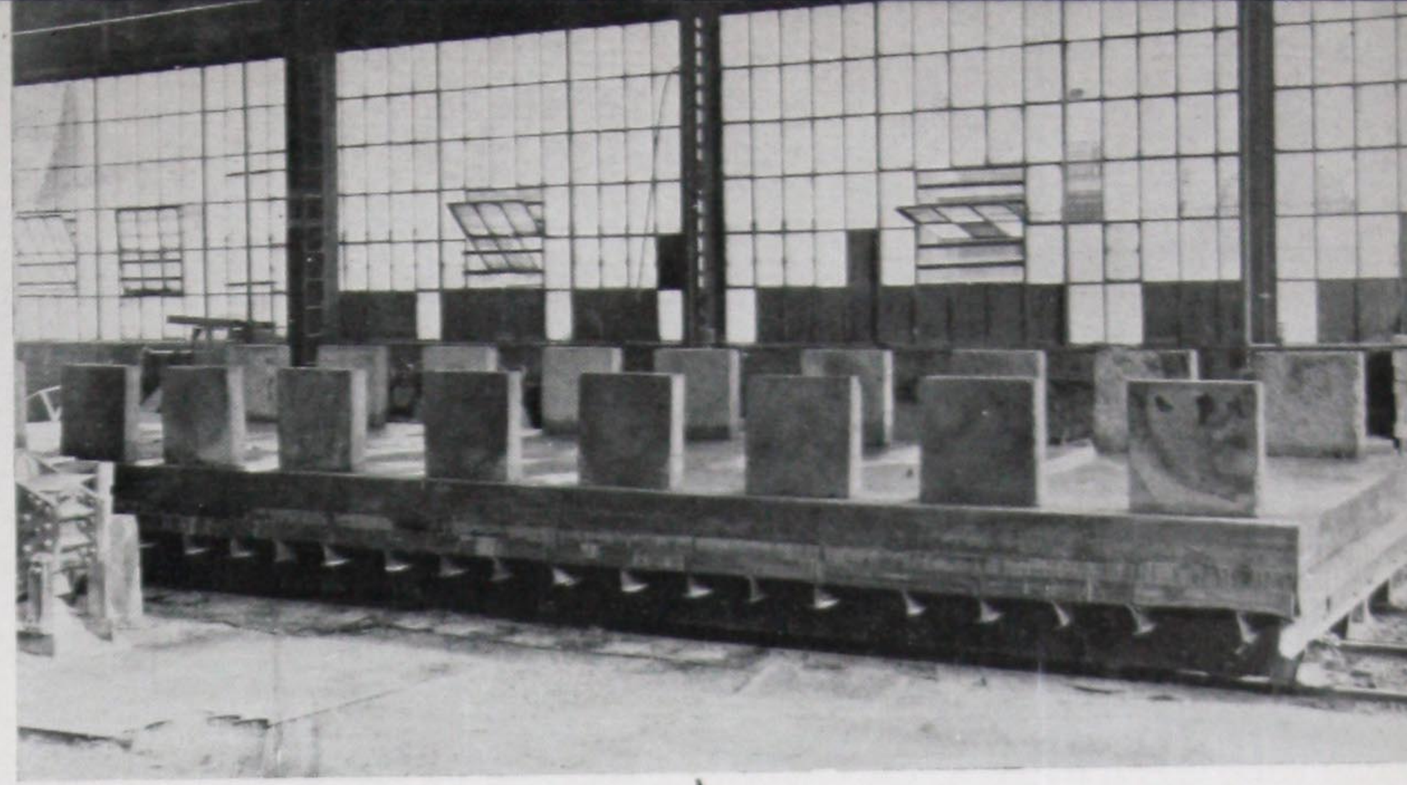
LUMNITE concrete exposed to temperatures which cause the disintegration of ordinary concrete is known as Heat Resistant Concrete when the temperatures are not high enough to vitrify the material and form a ceramic bond. Furnace foundations, ducts carrying hot gases and floors subject to soaking heat are typical examples of Heat Resistant Concrete. Where ordinary structural concrete either cannot be used or does not have an economic life, concrete made with LUMNITE and suitable aggregates combines structural strength and resistance to heat. See Page 14.

## Insulating Concrete

Insulating Concrete is essentially Heat Resistant Concrete with low thermal conductivity. Several special aggregates are commercially available for making light-weight concrete with excellent insulating properties. The type of aggregate selected depends on the thermal conductivity and heat storage capacity desired in the Insulating Concrete. LUMNITE is used as the binder for the special aggregates because the concrete must be stable under high temperatures.

Insulating and refractory characteristics may be obtained together through the use of such aggregates as refractory-insulating-fire-brick grog or other special materials. See Page 19.

These three types of concrete—Refractory, Heat Resistant, Insulating—provide for a wide range of thermal conditions. All are made with LUMNITE and aggregates selected according to the requirements of the particular installation. With LUMNITE in stock and a supply of low-cost aggregates, materials are available for a great variety of furnace construction and maintenance jobs.



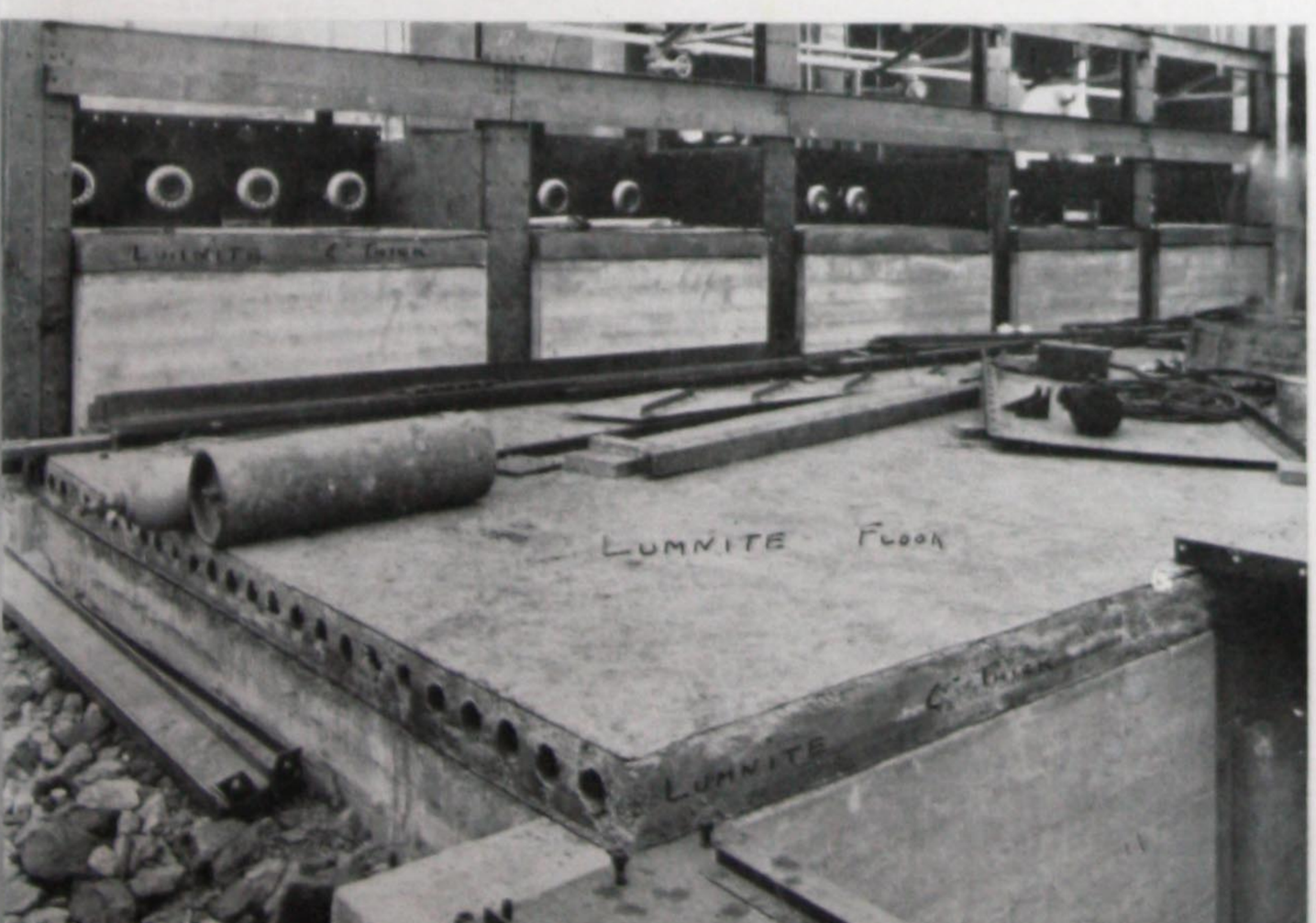
Refractory Concrete Car Top
and Baffles for Car Type
Annealing Furnace.
This furnace also has precast Refractory Concrete roof arch sections with span of about 14 feet 6 inches.

## Characteristics of LUMNITE

LUMNITE when mixed with water sets and hardens by chemical action without the application of heat. It is used *as the binder* for refractory, heat resistant and insulating aggregates in the making of these several kinds of concrete.

Concrete made with LUMNITE and suitable aggregates has the property of retaining a considerable part of its cold strength after continued exposure at high temperatures. LUMNITE is not in itself a refractory material. It is used in making Refractory Concrete because its effectiveness as a binder is not destroyed by the service temperatures.

LUMNITE is not a portland cement and it differs from portland cement in chemical composition and physical properties. LUMNITE is a calcium aluminate cement as distinguished from portland in which the principal constituents are calcium silicates. The calcium aluminate cements are the only commercial hydraulic cements which have heat resistant properties required for Refractory Concrete. LUMNITE is the only calcium aluminate cement made in America.




LUMNITE Concrete Used to Insulate
Floor Slab and Burner Ports of
Oil Still Furnace.
LUMNITE slab is placed over ordinary concrete foundation. Note ventilating ducts through floor slab.

# METHODS OF MAKING REFRACTORY CONCRETE

The proportioning of mixes and grading of aggregates for Refractory Concrete differ in principle and practice from those employed for structural concrete. The manipulation of LUMNITE also differs from that of ordinary structural cements. On the following pages we give suggestions for making Refractory Concrete suitable for several kinds of service. Great diversity in operating conditions and service requirements makes it difficult, if not impossible, to lay down hard and fast rules for formulating mixes. In general, the suggestions are based on satisfactory installations made by users of Refractory Concrete.

## Refractory Properties

LUMNITE may be used as a binder with acid, basic or neutral refractory aggregates. The refractory properties of the concrete depend on the aggregate. These properties are not necessarily the same as those of the aggregate in its original state. In general, the insulating value of Refractory Concrete will be somewhat greater than that of the refractory material with which the concrete is made. The refractory limit will be slightly lower than that of the aggregate. Refractory Concrete has consistently shown excellent non-spalling characteristics in tests and in service.

## Aggregate Selection

Selection of aggregate depends on service conditions and availability. On Pages 12 and 13 those which may be used within certain temperature ranges are listed under the classifications:

| | |
|---|---|
| Low Temperature Furnaces | 2000° F. and under |
| Medium Temperature Furnaces | 2000° F.-2750° F. |
| High Temperature Furnaces | 2750° F. and over |

## Aggregate Size and Grading

Particle size and grading of aggregate are of the greatest importance. Regardless of type, the aggregate should range from the maximum size particles *through all intermediate sizes* down to and including fines and dust. Maximum size may be ¾″ to 1½″ depending on thickness of section. When large sizes are not available aggregate of smaller maximum size may be used.

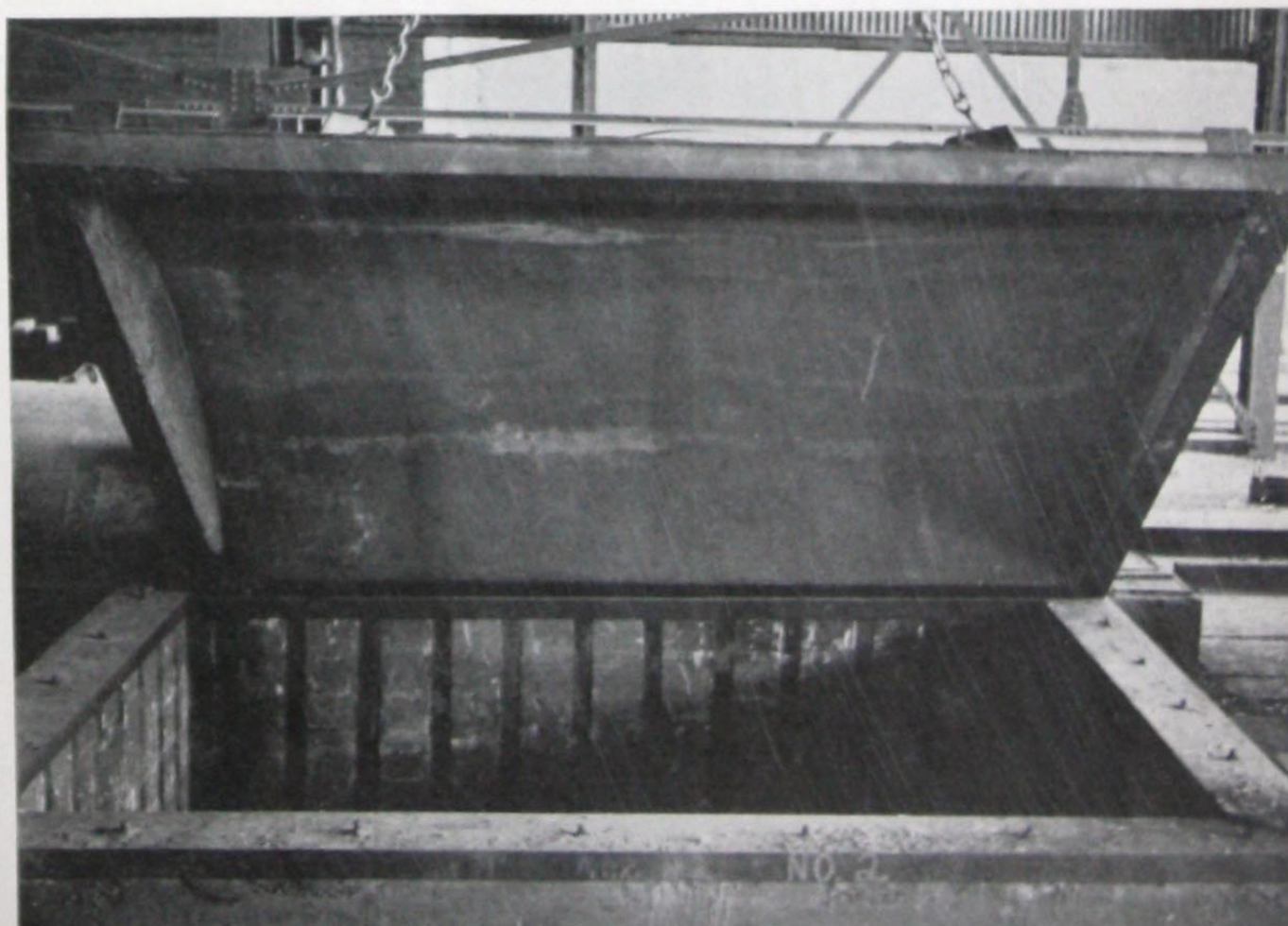
Approximately 50% of total aggregate should pass a ⅛″ screen. 15% to 18% should pass a 100 mesh screen. If necessary add fines to original crushing. Uniform grading is required in any case, *i.e.*, there must be intermediate sizes between the fine and the coarse particles.

When accurate sizing is impracticable an ordinary fly screen may be used. 35% of the total aggregate should pass the fly screen. Uniformity of grading can be determined visually by the presence of all particle sizes between fines and coarse.

Care should be taken to avoid mixing the clay fire brick with other kinds of bricks, such as common or silica brick. Old mortar and cements adhering to the brick should be cleaned off to prevent contamination of the LUMNITE.

## Proportions

Service temperature determines proportions of mix. Proportions for the several temperature ranges are given on Pages 12 and 13.



Slow Cooling Pit for Steel Billets. LUMNITE Refractory Concrete used for walls and bottom. Arched cover lined with LUMNITE Insulating Refractory Concrete to reduce weight and heat loss.

## Proportioning

Accurate measurement of binder and aggregate is important. One bag of LUMNITE contains one cubic foot weighing 94 pounds. When less than one cubic foot is required, the LUMNITE should be weighed. For example—if one cubic foot of Refractory Concrete is desired, using a 1:4 mix, measure ~~four feet~~ one foot of aggregate using cubic foot box, weigh out 23½ pounds of LUMNITE. Weigh the LUMNITE, do not measure in the cubic foot box. A finely divided material, such as LUMNITE, cannot be accurately measured by volume. It should be weighed when a fraction of a bag is needed.

All proportions are stated in terms of total aggregate. When two or more sizes are used to obtain proper gradation, proportions given in this book refer to quantities of aggregate after mixing together the two or more sizes.

## Molds and Forms

For most types of installations forms similar to those employed in concrete construction are used. Many fire doors because of their shape do not need any side molds or forms. When it is desired to have the lining thicker than the side flanges of the door, wooden forms or molds can be made to give the desired thickness of the lining. It is suggested that such forms be made with an inside taper and greased so they can be easily removed. If tapered sides are

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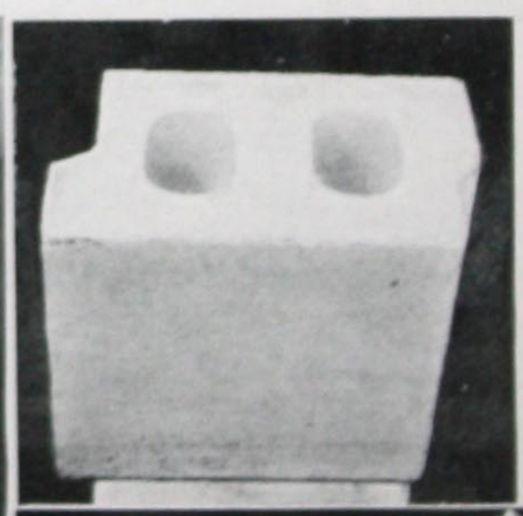
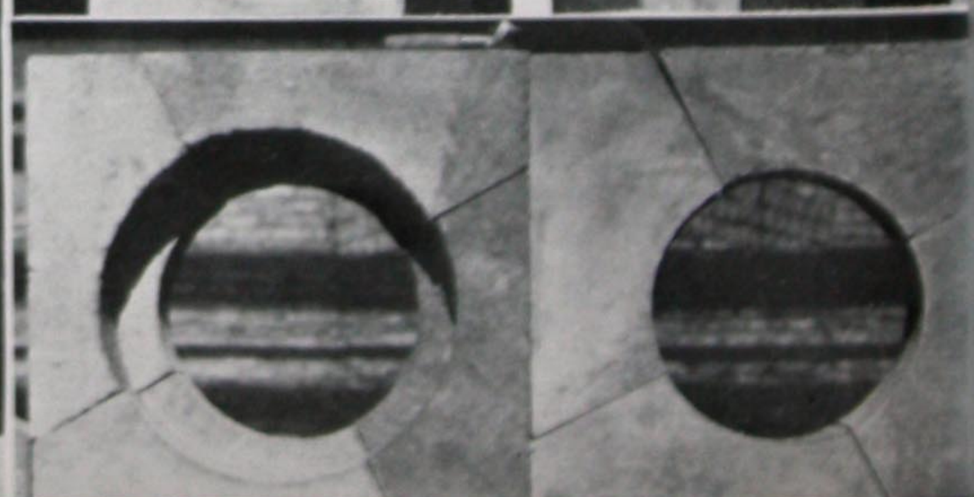
**Gas Gun Blocks for Coke Ovens**
**Any special shape may be made at the plant as required. Refractory properties are the same as cast-in-place Refractory Concrete.**

**Precast Refractory Concrete Shapes**
**The rapid hardening of LUMNITE facilitates the casting of special shapes. They may be handled and installed the day after making.**

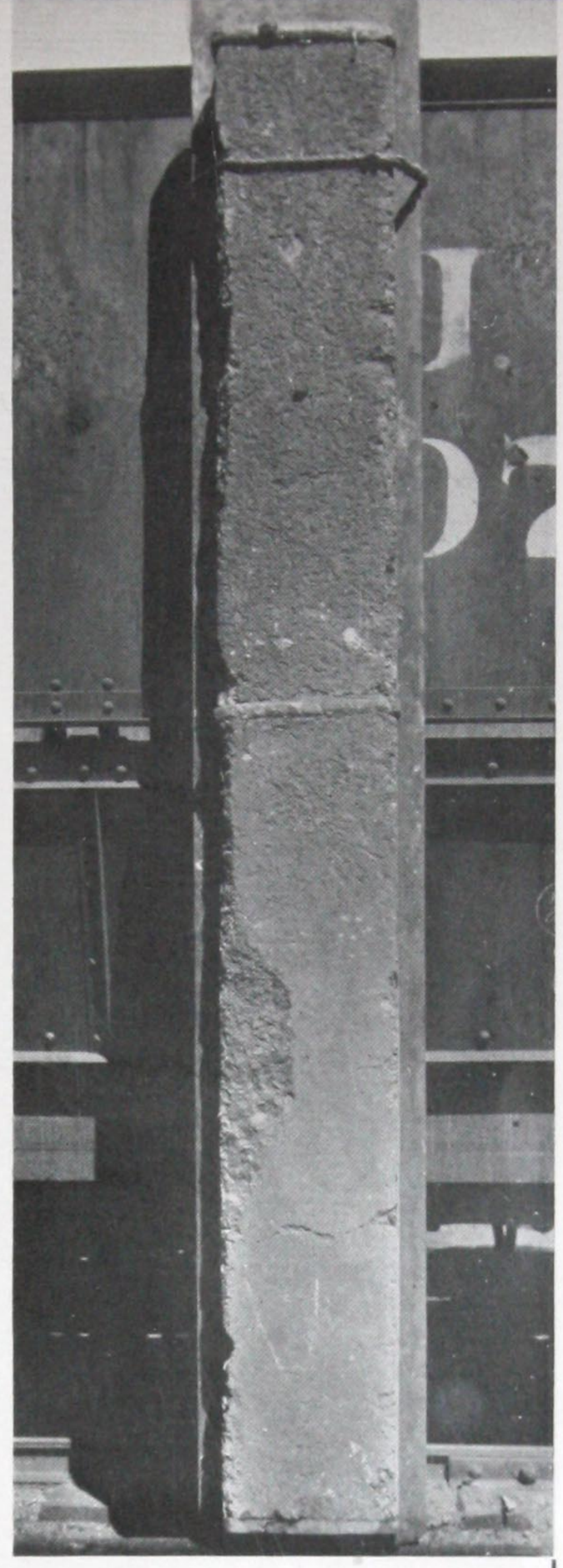




objectionable the corners of the wooden form may be fastened with screws or bolts for easy removal.

Metal reinforcement cannot be used in Refractory Concrete in the same manner as in ordinary structural concrete. At high temperatures carbon steel loses strength and disrupts the concrete. Heat-resistant steels have given better results. Special methods of design are required when Refractory Concrete is to be used for structural purposes. Information on this subject may be obtained from the Atlas Lumnite Cement Company, 135 East 42nd Street, New York, N. Y.

## Reinforcing



**LUMNITE Refractory Concrete Coke Oven Door Lining**

**This photograph was taken after the lining had been in continuous service for more than 5 years.**

## Mixing

When mixing Refractory Concrete first moisten the aggregate until it will not readily absorb any more water, then add the LUMNITE and mix to a uniform color.

Add sufficient cold water, not over 80° F., to make the mixture plastic, soft and sticky. If the aggregate contains sufficient fines and dust the mix will be plastic, easily placed by spading without ramming, and will not release free water. If the aggregate contains insufficient fines and dust to produce this consistency, the addition of small percentages of plastic fire clay will increase the plasticity. Fire brick aggregates will require a longer period of mixing than ordinary concrete aggregates in order to permit complete absorption of the water. Should the mix become dry during placing add more water and remix.

## Placing

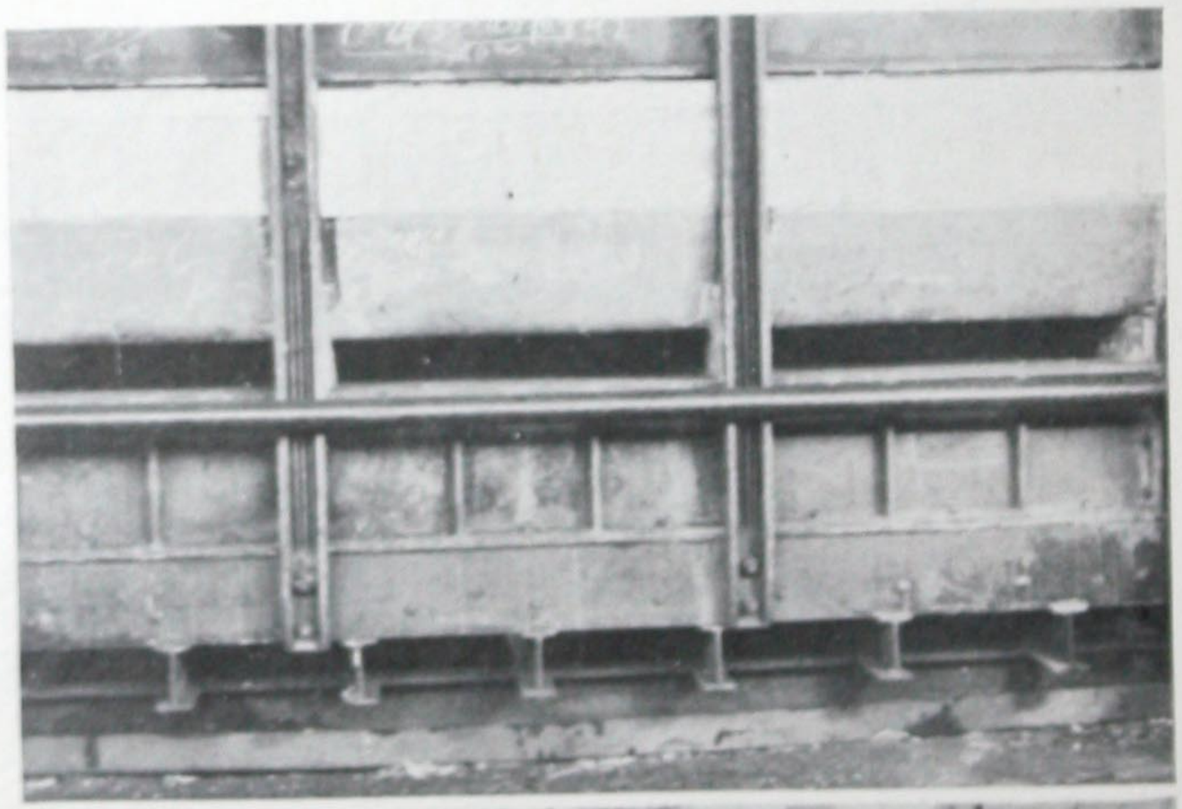
The concrete should be placed to avoid planes of weakness. For example, if a door is being lined which requires three batches, place the first batch to cover one-third of the area for the complete depth; the next batch for the second third of the area for the complete depth; the next batch to cover the last third of the area for the complete depth. The concrete should be spaded to densify and consolidate it. If a smooth surface is desired use only a wood float. A cement gun is sometimes used for placing refractory mortars.

## Curing

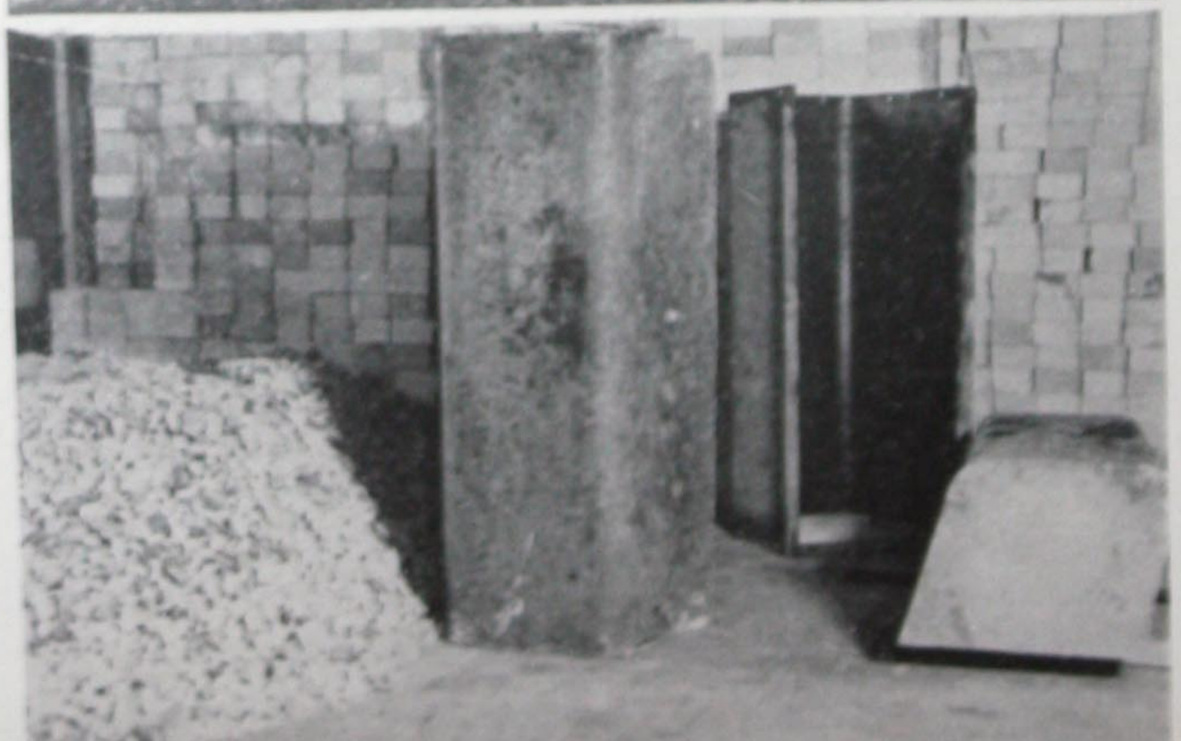
Best results are obtained if the exposed surface of the concrete is kept moist by sprinkling from six hours after mixing until twenty hours after mixing. This is of particular importance when dense aggregates are used, or the work is done in a place where high atmospheric temperatures prevail or where the air is very dry.

## Drying Before Using

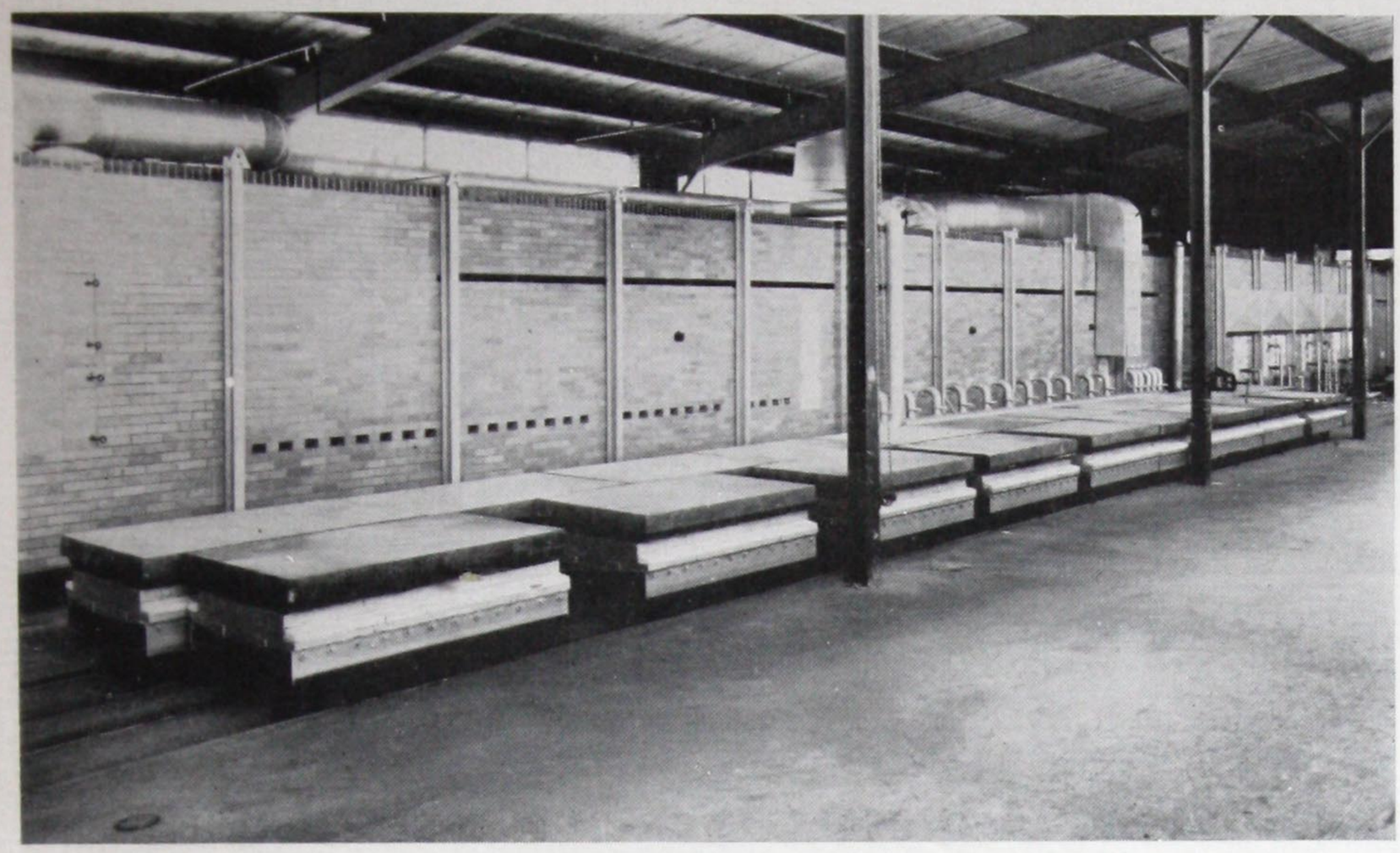
The rapid hardening of LUMNITE greatly aids the drying of Refractory Concrete linings. Predrying is important in work of considerable mass. If the concrete is to be subjected to high tempera-



**Precast LUMNITE Refractory Concrete Front Arches in Forge Furnace**
An example of Refractory Concrete in unusually severe service. The use of precast units facilitates replacement and maintenance.



**Aggregate and mold used in making the precast arch sections shown in the above picture. From left to right, grog pile, arch section on end, sheet steel mold, end view of arch section.**



**REFRACTORY CONCRETE TOPS FOR TUNNEL KILN CARS**

**The group of cars in the picture is part of the equipment of 50 cars, all topped with Refractory Concrete, in use at one tile plant.**

tures suddenly, as in the case of many door linings, better results will be secured if 48 to 60 hours elapse before the lining is put into service. When it is desirable to use the linings before this period a small amount of artificial drying may be necessary. The same care when first heating Refractory Concrete is required as when using other refractories.

When Refractory Concrete is heated on all sides, there is a noticeable shrinkage which is offset to a considerable extent (not entirely) by a small thermal expansion. When heated only on one side, shrinkage may develop hair cracks on the hot face or a few cracks extending into the concrete.

In each case, the thermal expansion of the materials while hot practically compensates for the initial shrinkage. In lining a furnace door, for example, the frame is filled with concrete. No allowance is made for expansion of the concrete.

## Expansion and Contraction

# Proportioning and Materials for Low,

## Low Temperature Service 2000° F. and Under

*Proportions*

1:4
(1 bag LUMNITE to 4 cu. ft. of aggregate).

Note—1 bag LUMNITE=1 cu. ft.=94 lbs.

See "Proportioning," Page 8.

A one bag batch of 1:4 mix will yield approximately four cubic feet of Refractory Concrete.

The load-bearing capacity of Refractory Concrete in service at 2000° F. and under will be increased with a somewhat richer mix. A 1:3 mix should be used where heavy loads will be imposed directly on the Refractory Concrete. This condition holds for some ceramic kiln car tops and some annealing furnace car tops where heavy ware and castings are fired.

*Aggregate*

Fire Clay Grog

Refractory Insulating Firebrick Grog (RIFB)

Crushed Firebrick

Crushed Insulating Brick

Crushed Pottery Saggers

Light Weight Refractory Aggregate (LWR)*

Olivine

Diatomaceous Silica† (Service Maximum 1800° F.)

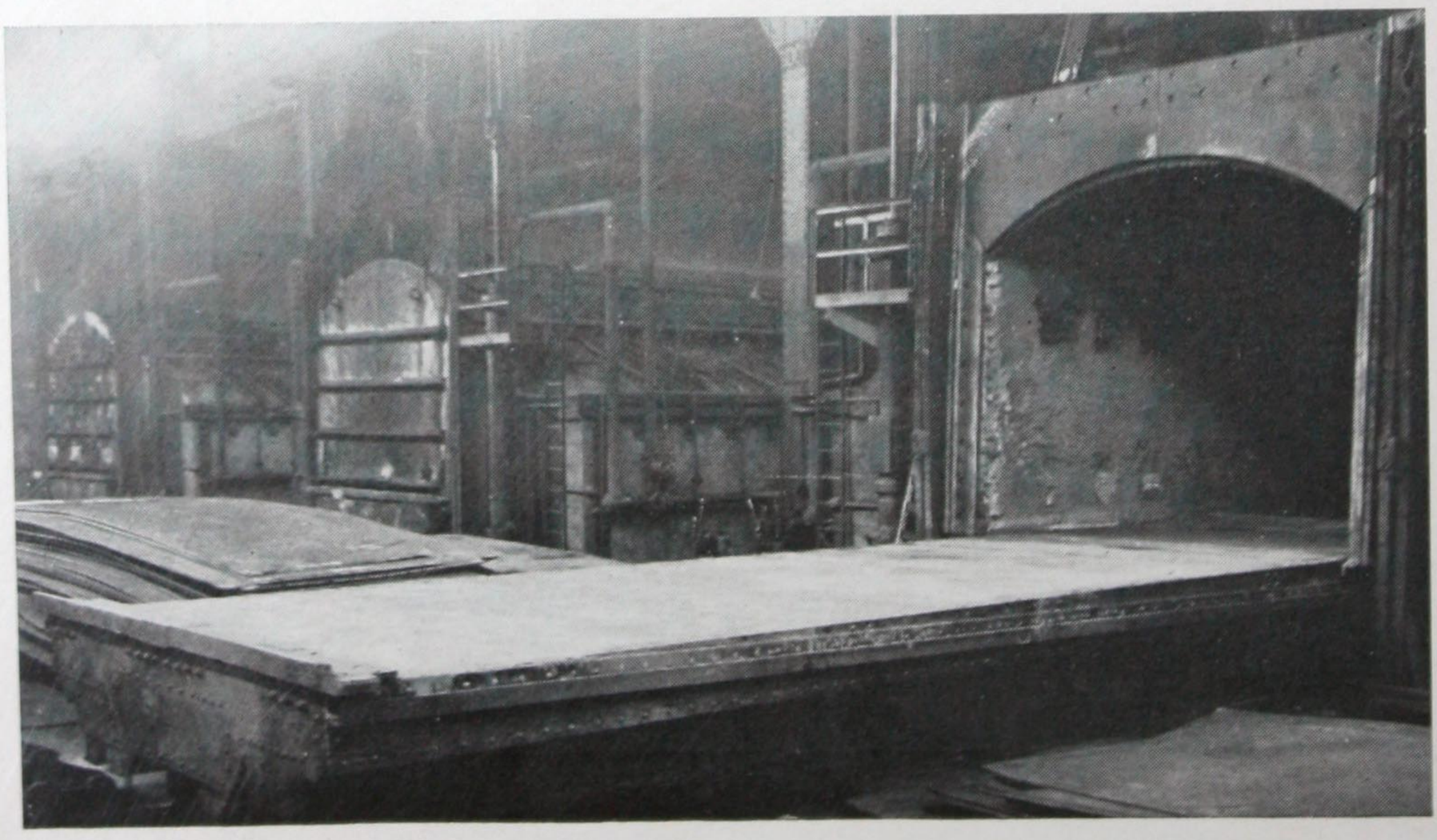
When both insulating and refractory properties are desired vermiculite may be used in combination with the fireclay and LWR aggregates. The addition of vermiculite increases the insulating value but decreases the strength and resistance to abrasion.

*Such as Gravelite, Haydite, Raylite

†Such as Sil-o-cel C-3

**ANNEALING FURNACE CAR TOP**

**A Refractory Concrete top 40 feet long, 12 feet wide, cast in place.**



# edium, and High Temperature Service

## Medium Temperature Service 2000° F. to 2750° F.

*Proportions*

| Service Temperature | LUMNITE | | Aggregate Cubic Feet |
|---|---|---|---|
| | Bags | | |
| 2000° F.-2250° F. | 1 | : | 5 |
| 2250° F.-2500° F. | 1 | : | 6 |
| 2500° F.-2750° F. | 1 | : | 7 |

Certain installations may require the aggregates suggested for high temperature furnaces.

When aggregates recommended for high temperature furnaces are used for medium temperature furnaces a 1:6 mix should be used.

*Aggregate*

Fire Clay Grog

Refractory Insulating Firebrick Grog*

Crushed Firebrick

Crushed Pottery Saggers

Olivine

For service between 2500° F. and 2750° F. aggregate should have a softening point of Cone 30 or higher.

*Maximum service temperature for any RIFB grog should be obtained from the manufacturer.

## High Temperature Service 2750° F. and Over

*Proportions*

1 bag LUMNITE to 6 or 7 cu. ft. of aggregate.

When Olivine is used in high temperature service it is desirable, and in most cases necessary, to remove the material passing a ¼" screen and substitute fines of one of the other materials, preferably chromite. A mix of 1 bag of LUMNITE, 4 cubic feet chromite or fused alumina, graded from ⅛" to dust, and 4 cubic feet of Olivine, graded from ¼" to ¾" or 1½", is suggested.

*Aggregate*

Bauxite
Chromite
Diaspore
Fused Alumina
Kyanite
Magnesite
Mullite
Olivine
Sillimanite

### SUMMARY OF REFRACTORY CONCRETE MIXES

| FURNACE TEMPERATURES | PROPORTIONS | | KIND OF AGGREGATE | Bags LUMNITE per cu. yd. of Refractory Concrete |
|---|---|---|---|---|
| | LUMNITE (bags) | Aggregates (Cu. Ft.) | | |
| Up to 2000° F. | 1 | 4 | Clay aggregates; olivine | 6.75 |
| 2000° F. to 2250° F. | 1 | 5 | Clay aggregates; olivine | 5.40 |
| 2250° F. to 2500° F. | 1 | 6 | Clay aggregates; olivine; special aggregates* | 4.50 |
| 2500° F. to 2750° F. | 1 | 6 to 7 | Clay aggregates; olivine; special aggregates* | 4.50 to 3.86 |
| Above 2750° F. | 1 | 6 to 7 | Special aggregates* | |

*See list under "High Temperature Service"

# HEAT RESISTANT CONCRETE

The disintegration of ordinary concrete by continued exposure to high temperatures creates a serious problem in the construction of furnace foundations. Floors under and around furnaces, ducts and flues carrying hot gases are subject to the same destructive effect.

Experience has shown that LUMNITE concrete when made with suitable aggregates offers a much greater degree of resistance to the disintegrating effect of "soaking heat." Although the strength of all concrete is lowered by continuous exposure to heat, many of the advantages of concrete construction are retained in LUMNITE Heat Resistant Concrete.

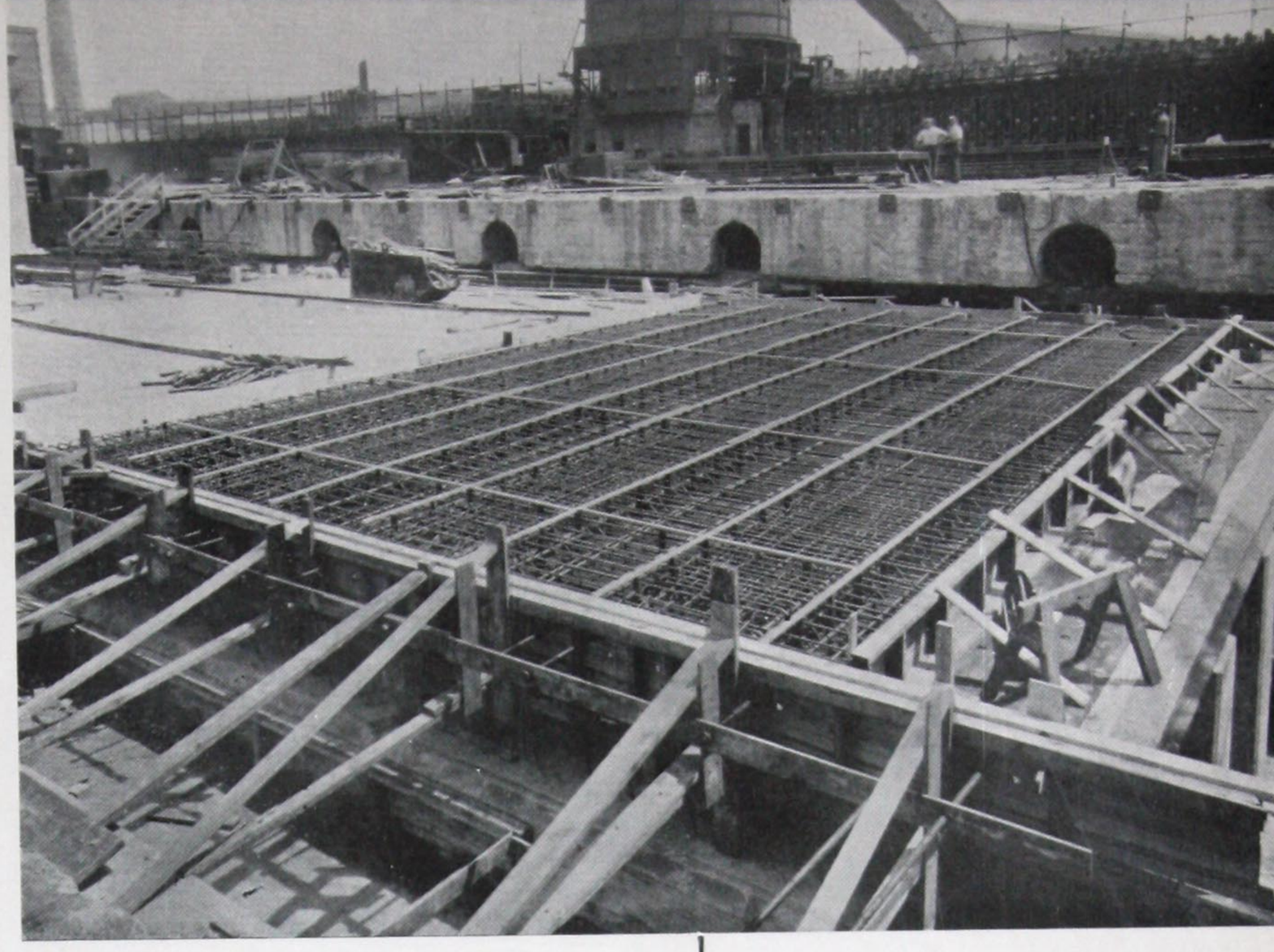
For Heat Resistant Concrete, materials which release lime must not be used. LUMNITE is the only American-made hydraulic cement which does not release lime during the hardening period or after the concrete has been exposed to heat.

## Heat Resistant Foundations

**Design**

Proper design of the foundation will facilitate its construction with LUMNITE concrete and extend its service life. In all cases the foundation should be so constructed as to dissipate the heat which is built up in the mass of concrete exposed to the high temperatures. Ventilating ducts through the concrete will assist such dissipation. This ventilation also aids in carrying off the heat generated by the hydration of the LUMNITE. The hardening action of LUMNITE, on account of its rapidity, causes the evolution of considerable heat during the first 24 hours after the concrete is mixed.

Heat Resistant and Insulating Concrete, in combination, are sometimes used in furnace construction. An insulating slab, similar to that shown in the picture at the bottom of Page 5 is placed on a heat resistant foundation. Heat Resistant Concrete is employed when it is expected that relatively high temperatures will eventually be built up in the foundation during continuous operation of the furnace.



**HEAT RESISTANT CONCRETE**

**Construction view of LUMNITE concrete slab to support regenerator walls of underburner regenerative by-product coke ovens.**

## Aggregate

Old fire brick, paving brick or hard-burned common brick, when crushed to the required sizes, will be found more satisfactory than sand and gravel which are often high in silica. Trap rock, both fines and coarse, may be used.

Light-weight refractory aggregates, such as Gravelite, Haydite and Raylite, are suitable especially where insulation is desired. Air-cooled blast furnace slag has been used at temperatures below 1000° F. Slag is not recommended above that temperature.

Lime-releasing aggregates should be avoided. Materials such as silica aggregates which undergo sudden volume change when heated must not be used.

The coarse aggregate should be retained on a screen having round openings of ¼". The maximum size particle may be from ¾" to 1½". The fine aggregate should pass a ¼" round opening and have some fines passing a 100 mesh sieve.

## Proportions

1 bag (1 cu. ft.) of LUMNITE, 2½ cu. ft. fine aggregate, and 2½ cu. ft. of coarse aggregate. If the mix is harsh, increase the fine aggregate and decrease the coarse aggregate in equal proportions. With harsh aggregates mixes such as 1:3:2 and 1:3:2½ have been used. Lime or other soluble admixtures intended to improve plasticity must *not* be used with LUMITE.

## Placing

LUMNITE concrete is placed in the same manner as ordinary concrete. When large masses of LUMNITE concrete are desired it may be advisable to place them in more than one operation. In general the thickness of a large slab placed at one time should not be greater than 15 inches, unless special provision is made for curing. When a large mass of concrete is placed in two layers 24 hours should be allowed for the curing of the first layers before the concrete for the second layer is placed.

## Curing

After the concrete has set (from 6 to 10 hours after placing, depending on atmospheric conditions and temperature of concrete when placed) the concrete should be kept moist by sprinkling with water until it is 24 hours old. The time for first application of curing water may be determined by rubbing the surface with a moistened finger. If the finger is clean after the rubbing, sprinkling should start. If the finger is soiled by the test, sprinkling should be withheld.

## Floors Exposed to Direct or Indirect Heat

For best results a monolithic, one course heat resistant floor should be placed. Thin heat resistant top courses on ordinary concrete base slabs are not recommended.

Floors continuously exposed to high temperatures do not have the wearing quality of ordinary, unheated concrete. They cannot be expected to withstand abrasion from trucking, dragging of skids or other severe wear.

## Aggregate

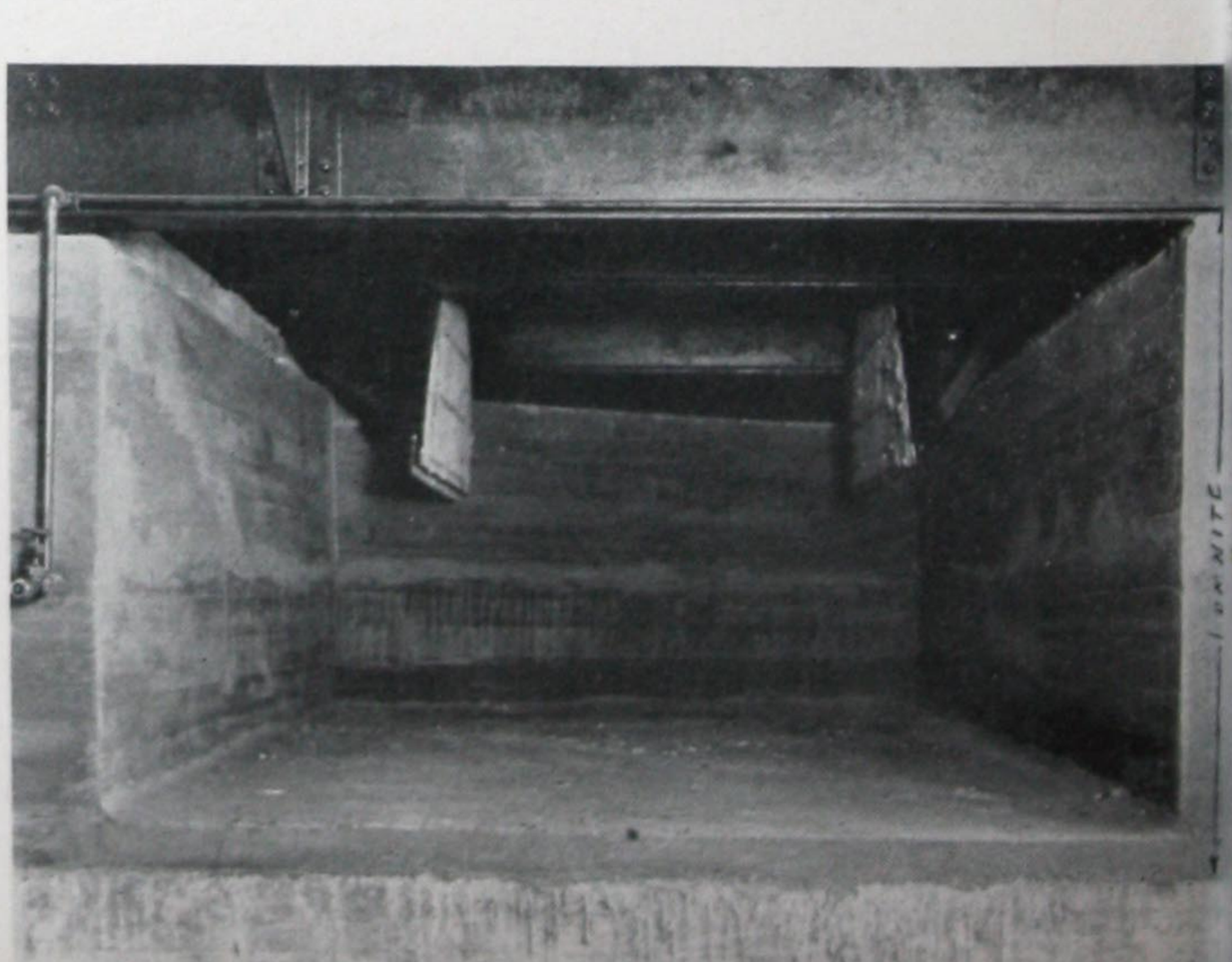
Crushed old firebrick, paving brick or hard-burned common brick may be used. Trap rock, fine and coarse, is also satisfactory. The harder aggregates will give a better wearing surface. Light weight refractory aggregates are serviceable from standpoint of heat resistance but should not be used for floors subject to traffic.

## Proportions

A mix of 1 bag LUMNITE, 2½ cu. ft. fine aggregate, 2½ cu. ft. coarse aggregate is generally satisfactory. The mix may be adjusted as described under "Heat Resistant Foundations" to improve workability for placing and finishing.

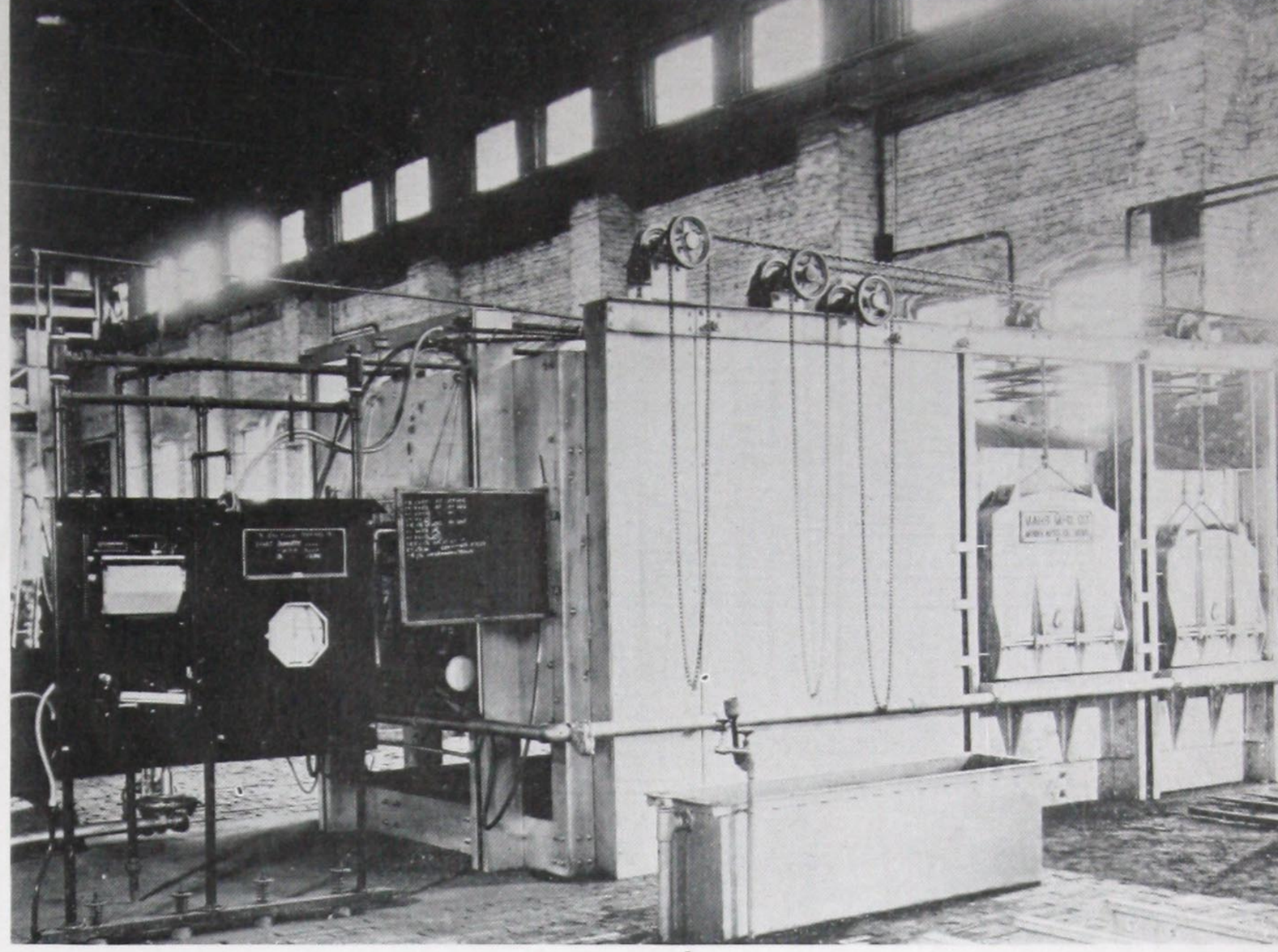
## Placing

All operations in placing LUMNITE Heat Resistant Floors, except as noted above, are the same as for LUMNITE concrete floors for the usual structural purposes. Full information on this subject will be found in the pamphlet "LUMNITE for Structural Concrete."



Heat Resistant Concrete Foundation for Foundry Cupola.

A slab approximately six inches thick was placed over ordinary concrete foundation.



Billet Heating Furnace erected on LUMNITE Heat Resistant Concrete slab. The three furnace doors are lined with Refractory Concrete

## Flues and Ducts

LUMNITE Heat Resistant Concrete is an adaptable material for the construction of ducts carrying hot gases. Many satisfactory installations have been made, especially in oil refineries.

Several types of duct have been developed by LUMNITE users. Monolithic LUMNITE concrete structures have been built in some cases. In others precast sections are used. LUMNITE protective linings have been placed in ducts built of reinforced portland cement concrete. Where ducts are placed partially underground or where dissipation of heat is inadequate, it is desirable to provide ventilating flues in the concrete. One convenient method is to connect the ventilating flues into the chimney. The draft will provide a continuous flow of air to carry off the heat and reduce the heat storage in the concrete.

The light-weight clay aggregates are in general use for these LUMNITE concrete ducts. The concrete has adequate structural strength, low heat storage capacity and high insulating value. (See information on Insulating Concrete on following pages.)

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LUMNITE is not a portland cement. Methods of use are somewhat different from portland cement practice, especially in curing procedure. The pamphlet "LUMNITE for Structural Concrete" should be studied carefully before constructing foundations or floors of Heat Resistant Concrete.

## Design

## Aggregate

## Caution

## Sealing Ovens, Kilns, and Furnaces

Prevention of infiltration of air in ovens, kilns and furnaces is of prime importance in many industries. When the equipment is exposed to the elements it must be sealed against the entrance of water as well as air. LUMNITE mixtures have been used for sealing such units with satisfactory results, both on sheltered equipment and on that exposed to wind and rain.

### Mixes

The mixes used approximate one part LUMNITE to 2½ parts aggregate graded from ⅛″ or 3/16″ maximum size, down to and including fine particles. For application with a trowel sufficient water should be added to give a plastic mix. For cement gun work the amount of mixing water will be controlled by the operation of the gun.

### Aggregate

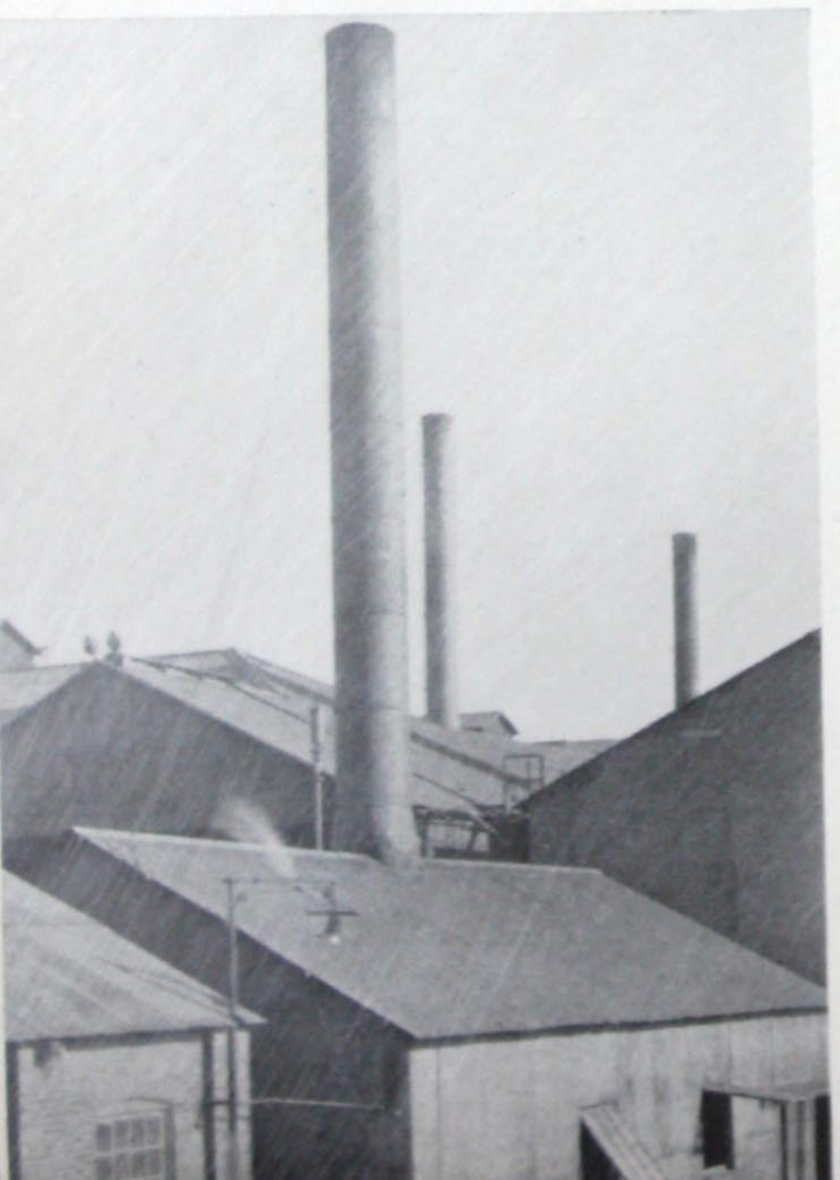
The aggregate used with LUMNITE should be of the same general nature as the brick to which the mortar is applied. For example, on clay fire brick, ground clay fire brick or Haydite can be used as the aggregate. On silica brick, silica sand should be used.

### Application

The wall should be cleaned of all dirt and loose particles. When the temperature of the surface of the wall to which the mortar is to be applied is 200° F. or lower, the brick wall should be moistened before the mortar is applied. At temperatures above 200° F. it is doubtful if the wall can be successfully moistened.

Particularly on vertical or hot walls the use of a cement gun for applying the mortar will be of great help in obtaining the best results. When no cement gun is available the mortar may be applied by troweling. The seal coat is usually from ½″ to ¾″ thick.

Sprinkling of the LUMNITE mortar after it has set is essential. Under ordinary conditions at atmospheric temperatures the set will occur in 6 to 8 hours after placing. When the mortar is applied to hot walls the set will be speeded up. The test and directions for curing on Page 16 should be followed.



## Stacks and Chimneys

LUMNITE is widely used for protective linings of steel stacks and for mortar in brick and tile chimneys. In addition to refractory properties LUMNITE mortar is resistant to the corrosive action of chimney gases.

A special illustrated folder, "LUMNITE in Stacks and Chimneys," describes these uses.

**A Typical Industrial Stack with LUMNITE Refractory, Insulating, Corrosion Resistant Lining. Same type of lining used in boiler breechings.**

# INSULATING CONCRETE

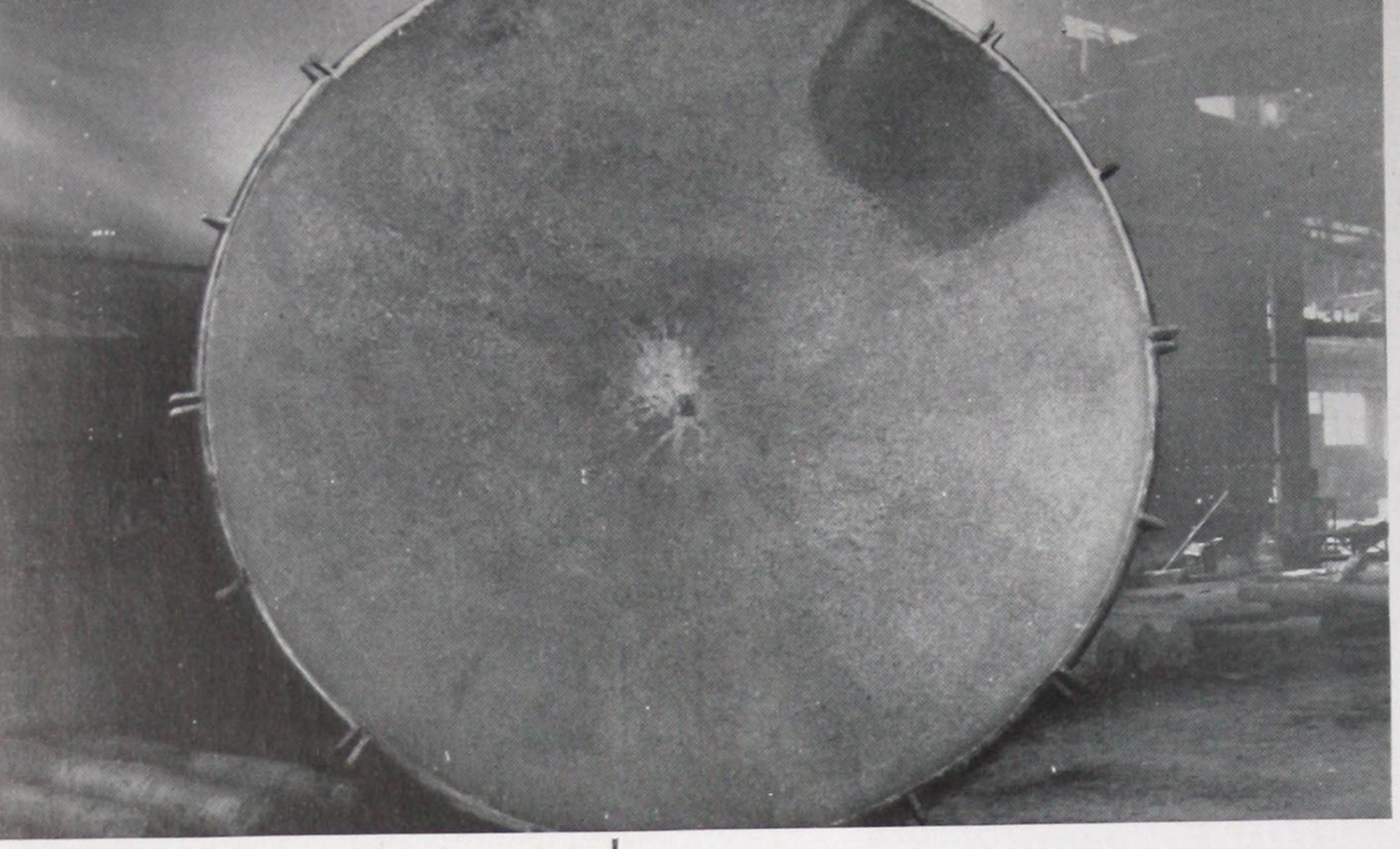
Insulating Concrete is a special type of Heat Resistant Concrete. It may also have refractory properties, in which case it is essentially Refractory Concrete of low thermal conductivity. Insulating Concrete made with certain aggregates has structural strength greater than that of most walls laid up with the usual insulating brick.

Structural strength and low thermal conductivity make possible the use of Insulating Concrete as a back-up to Refractory Concrete or other refractories. The Insulating Concrete gives added strength to the wall. It can be used in many cases to replace both insulating brick and the outer layer of common brick. Higher insulating value, lower heat storage, ample strength, reduced dead load and lower initial cost result from the use of Insulating Concrete in this manner.

Steel jackets can often be eliminated when Insulating Concrete is used for outside walls of furnaces. The walls may be reinforced with angles or T-irons. One flange is embedded in the concrete and the other flange (or flanges of T-iron) is exposed to the air on the outside of the wall. The embedded flange should not extend more than halfway through the thickness of the Insulating Concrete. This reinforcing will greatly increase the structural strength of the outside walls, eliminating the more expensive method of jacketing the furnace with steel sheets or plates.

Furnace walls of Insulating Concrete may be built without a fire brick inner lining when the concrete is made with suitable aggregates. Monolithic walls with few or no joints are more efficient in operation than brick masonry walls with many joints. A surface wash or coating on the inside of the furnace is seldom necessary when the higher-strength, light-weight, clay aggregates are used.

Refractory-Insulating Concrete is made, with LUMNITE, at about the same cost as ordinary Refractory Concrete. A monolithic Refractory-Insulating Concrete wall or roof arch can usually be built at a cost comparable with plain refractory construction.



Annealing Furnace Cover lined with Refractory Concrete. A jointless, cast-in-place lining 12 feet in diameter.

## Aggregates for Insulating Concrete

The aggregate for Insulating Concrete should be as strong structurally as possible without sacrifice of the required insulating value. Strong structural concrete cannot be made with structurally weak aggregates. Where strength is not a factor, better insulation can be obtained through the use of the more efficient, but structurally weaker, insulating aggregates. Combinations of aggregates can be used to produce concrete having the highest insulating value consistent with the structural strength required for any particular installation.

Aggregates commonly used for Insulating Concrete at temperatures up to 2000° F. include: Gravelite, Haydite, Raylite, Sil-o-cel, vermiculite, The first three are light-weight processed aggregates of relatively high strength. Sil-o-cel is one of a number of diatomaceous aggregates of medium strength.

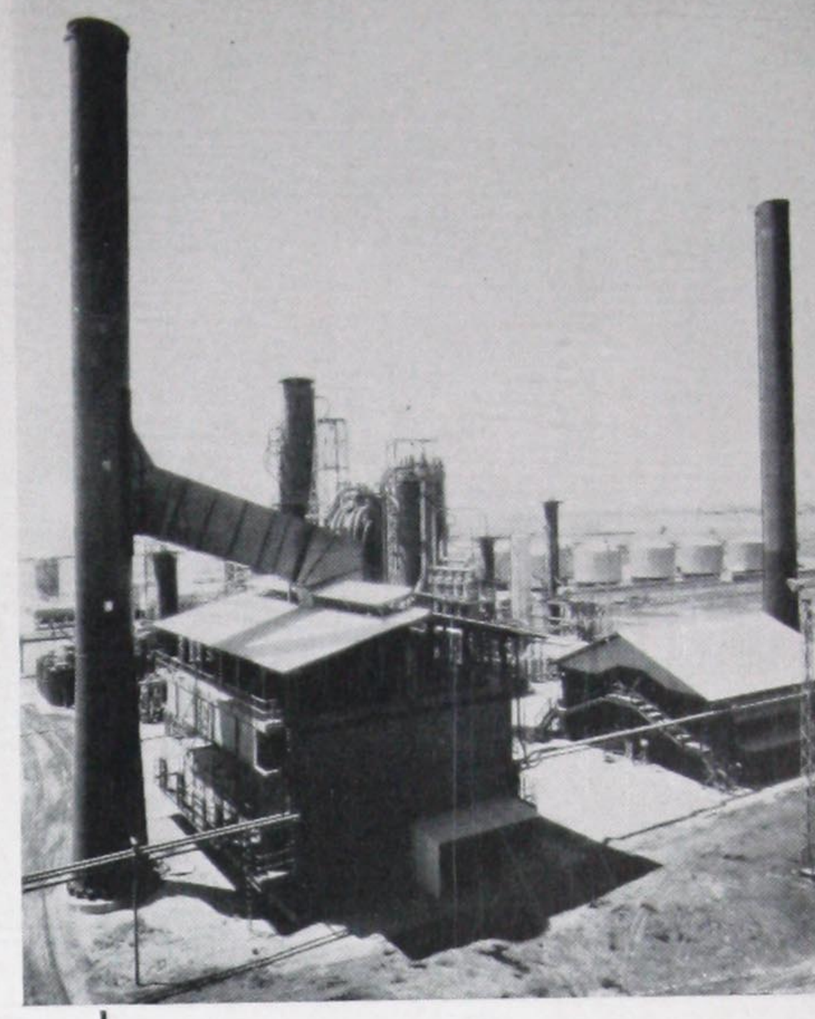
Vermiculite is an exfoliated mica of low strength marketed under various trade names, one of which is Zonolite. With vermiculite mixes the concrete should be compacted after placing to secure greater strength. Degree of compaction depends on proportion of vermiculite used. Conductivities of several mixes of vermiculite with other insulating aggregates are given in the table on Page 21. It is also used in combination with crushed firebrick.

In temperatures above 2000° F. several light-weight aggregates made from fire clay are available. (These are generally known as insulating fire brick grogs.) The names of manufacturers and producers of these special aggregates can be obtained from The Atlas Lumnite Cement Company.

LUMNITE Heat Resistant—Insulating Concrete is used extensively in Oil Refinery Construction.

LUMNITE concrete made with a light-weight clay aggregate is used for insulating tube sheets, tube header compartments and air-cooled floor slab in the Oil Still Furnace pictured in the foreground.

LUMNITE concrete slabs are also placed at the top of heaters of this type to act as insulation and provide an upper working floor.



## Proportions for Insulating Concrete

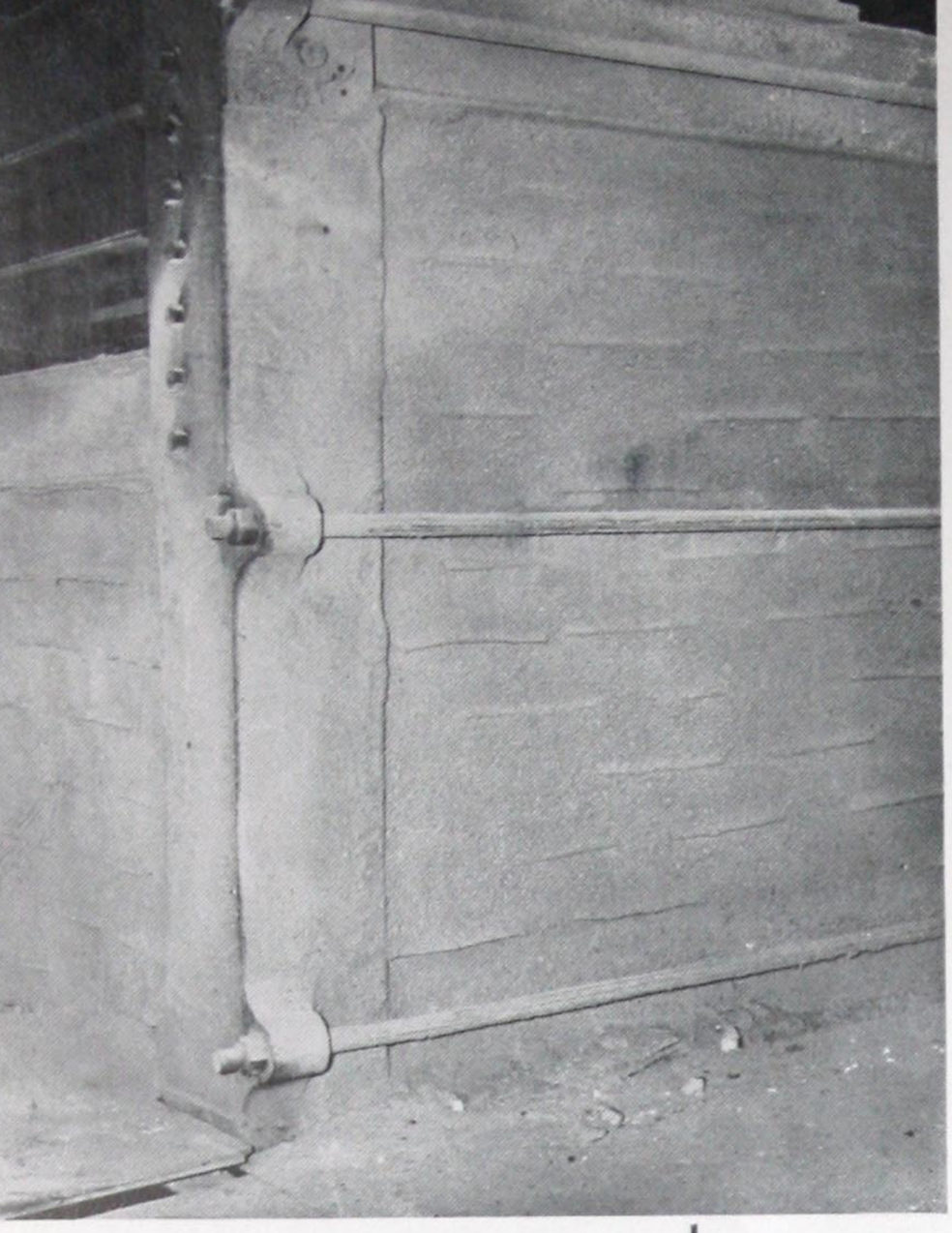
Proportions of LUMNITE and one or more aggregates vary over a wide range. They depend on the required insulating value (thermal conductivity) and on the desired structural strength. Mixes such as those tabulated below are in common use.

| LUMNITE Sacks | AGGREGATE Cubic Feet | AGGREGATE Type | Conductivity "K"* B.T.U./sq. ft./in./°F. hr. |
|---|---|---|---|
| 1 | 4 | Light wt. clay Agg. | 3.5 |
| 1 | 5 | Light wt. clay Agg. | 3.25 |
| 1 | 6 | Light wt. clay Agg. | 3.0 |
| 1 | 4<br>2 | Light wt. clay Agg.<br>Vermiculite | 2.5 |
| 1 | 3<br>3 | Light wt. clay Agg.<br>Vermiculite | 2.25 |
| 1 | 2<br>4 | Light wt. clay Agg.<br>Vermiculite | 2.0 |
| 1 | 6 | Vermiculite | 1.5 |

*Approximate values at 1500° F. Mean Temperature.

The mixes are tabulated in the order of structural strength, the strongest (1:4 with clay aggregate) at the top, the weakest (1:6 with vermiculite) at the bottom.

Details of mixing, placing and curing Insulating Concrete are the same as for Refractory Concrete, see Pages 9 to 11.



Bulkhead of Open Hearth Furnace. LUMNITE Insulating Concrete applied with a cement gun. Note sheet metal supports inserted at every fourth joint.

## Insulating Over-Coats

Insulation applied to a cold furnace frequently is cracked by expansion when the furnace is heated. Infiltration of air through the cracks reduces the efficiency of the furnace and increases operating costs. Application of an insulating overcoat to the hot furnace prevents this infiltration to a large extent. LUMNITE insulating mixes applied with a cement gun solve the problem of placing insulation on a hot furnace.

### Placing

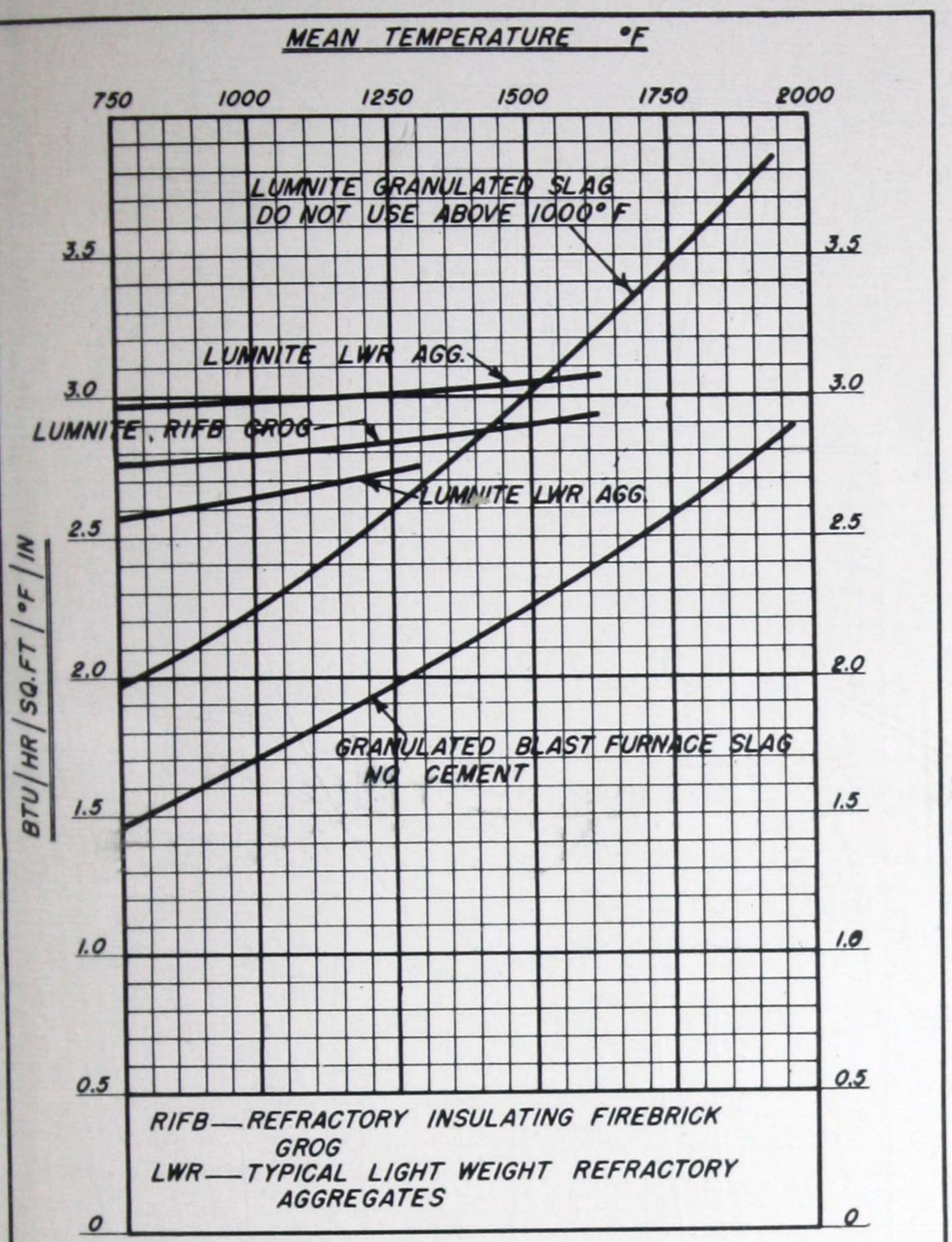
The application can be made while the furnace is in operation. The refractory insulating materials are expanded by the heat of the furnace when the mixture is applied. Cooling of the furnace further compresses the insulation, which should have sufficient resilience to minimize cracking. The insulation may be built up to any desired thickness by shooting on successive coats.

### Aggregate

Any of the aggregates suggested for Insulating Concrete may be used with LUMNITE for application with a cement gun. Aggregate should be selected in accordance with the temperature conditions, size and grading being determined by the requirements of cement gun work.

### Proportions

Suitable proportions have been worked out in the field by a number of users of these LUMNITE mixtures for their special purposes. Proportions will vary with aggregates used and working conditions. Mixtures as lean as 1 bag of LUMNITE to 10 cubic feet of aggregate have been applied successfully. If greater strength is needed the mix may be as rich as 1 bag of LUMNITE to 5 cubic feet of aggregate. With the leaner mixtures it may be necessary to add a small amount of fireclay to provide necessary adhesiveness and prevent excessive rebound.



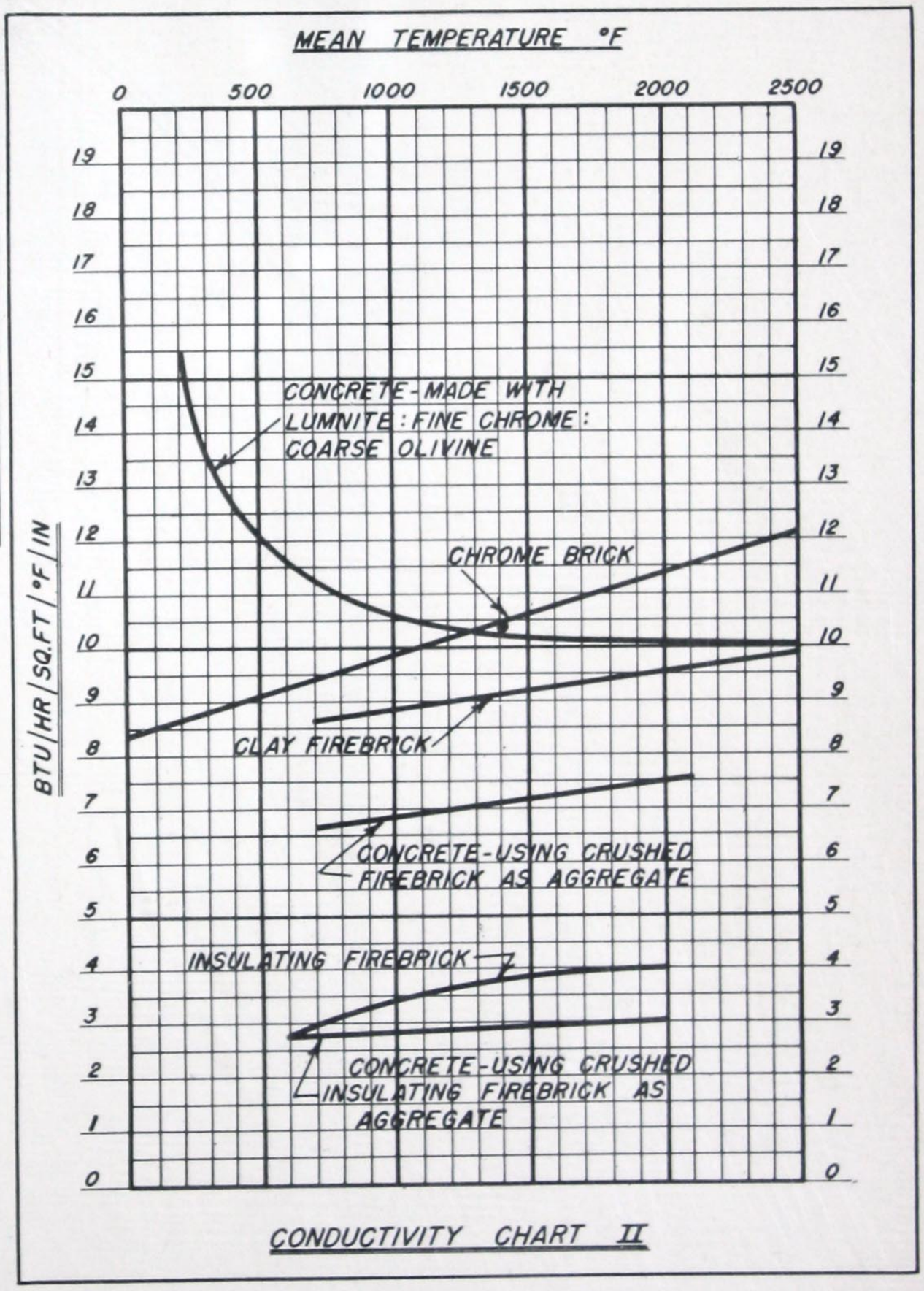

CONDUCTIVITY CHART I

## Conductivity Chart No. 1

These Conductivity Charts show comparative insulating values of several types of Refractory Concrete and other materials.

## Conductivity Chart No. 2

The curves were prepared from data obtained from a number of manufacturers and other sources. The several aggregates are believed to be typical of those in their respective classes.




CONDUCTIVITY CHART II

# Temperature Conversion Chart

Service Range Refractory Concrete

Lumnite—Magnesite Chrome

Lumnite—Chrome

Lumnite Olivine

Lumnite—High Refractory Clay Aggregate

Lumnite—Low Refractory Clay Aggregate

| Deg. F | Deg. C | Deg. F | Cone | Deg. C | Deg. F | Deg. C |
|---|---|---|---|---|---|---|
| 3400 | 1871 | | | | | |
| | | 3335 | 38 | 1835 | | |
| 3300 | 1815.5 | 3290 | 36 | 1810 | 3272 | 1800 |
| | | 3245 | 35 | 1785 | | |
| 3200 | 1760 | 3173 | 33 | 1745 | | |
| 3100 | 1705 | 3092 | 32 | 1700 | 3092 | 1700 |
| 3000 | 1648.5 | 3002 | 30 | 1650 | | |
| | | 2939 | 28 | 1615 | | |
| 2900 | 1593 | 2876 | 23 | 1580 | 2912 | 1600 |
| 2800 | 1537.5 | 2786 | 20 | 1530 | | |
| 2700 | 1483 | 2714 | 18 | 1490 | 2732 | 1500 |
| | | 2669 | 16 | 1465 | | |
| 2600 | 1476.5 | 2615 | 15 | 1435 | | |
| | | 2552 | 14 | 1400 | 2552 | 1400 |
| 2500 | 1371 | | | | | |
| | | 2462 | 13 | 1350 | | |
| 2400 | 1315.5 | 2417 | 11 | 1325 | | |
| | | 2345 | 9 | 1285 | 2372 | 1300 |
| 2300 | 1260 | 2300 | 8 | 1260 | | |
| | | 2246 | 6 | 1230 | | |
| 2200 | 1204 | 2201 | 5 | 1205 | 2192 | 1200 |
| | | 2138 | 3 | 1170 | | |
| 2100 | 1149 | 2093 | 01 | 1145 | | |
| | | 2039 | 03 | 1115 | | |
| 2000 | 1093 | | | | 2012 | 1100 |
| | | 1940 | 04 | 1060 | | |
| 1900 | 1038 | 1904 | 05 | 1040 | | |
| | | | | | 1832 | 1000 |
| 1800 | 982 | 1814 | 07 | 990 | | |
| | | 1742 | 08 | 950 | | |
| 1700 | 926 | 1706 | 09 | 930 | | |
| | | | | | 1652 | 900 |
| 1600 | 872 | 1607 | 012 | 875 | | |
| | | 1526 | 014 | 830 | | |
| 1500 | 816 | 1463 | 016 | 795 | 1472 | 800 |
| 1400 | 760 | | | | | |
| | | 1328 | 018 | 720 | | |
| 1300 | 704 | | | | 1292 | 700 |
| | | 1202 | 020 | 650 | | |
| 1200 | 648.5 | | | | | |
| | | 1121 | 022 | 605 | | |
| 1100 | 593 | | | | 1112 | 600 |
| | | Cones Heated At 150°C | | | | |
| 1000 | 537.8 | | | | | |
| | | | | | 932 | 500 |

Service Range Insulating Concrete

Lumnite—Low Refractory Aggregate

Lumnite—Vermiculite High Refractory Aggregate

Lumnite—High Refractory Aggregate

Service ranges of several types of Refractory Concrete are indicated on the left side of the chart. Service ranges for a number of Insulating Concretes are shown on the right.

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